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MANAGEMENT OF LABOR IN SUCCESSFUL METAL-MINE OPERATIONS

BY

CHARLES WILL WRIGHT

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DEPARTMENT OF COMMERCE - BUREAU OF MINES

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By Charles Will Wright[2]

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INTRODUCTION

This paper is one of a series dealing with mining problems and summarizing the data contained in the Information Circulars on individual mines that have been prepared by the managers or superintendents and published by the Bureau of Mines.

The purpose of this paper is to present the problems encountered in the development of an efficient mine organization and to show the means used by certain mining companies in promoting efficiency. There is also a discussion of the advantages and disadvantages of the various systems of paying and handling labor and a description of their application at the individual mines.

The manager of every producing mine, with the exception of gold mines, is to-day faced with the necessity of lowering unit production costs to meet the present low market prices for the metal products. To do so he is introducing ways to improve the efficiency of labor and where possible is maintaining his operative force and the wage scale.

At those mines where production has been suspended, there are certain fixed expenditures for the maintenance of both the mine workings and organization, as well as taxes that must continue in order to keep the mine alive, and just how far the management can go in making such expenditures is another problem that the management has to solve. At certain mines,

1 - The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6650."

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however, it has been possible to reduce production costs by one-half, due to improved efficiency and perhaps a small decrease in wages, which reduction has permitted these mines to continue profitable operations. It has also been noted that where workmen have been dropped from the company's pay roll, there has been a greater output per man among those remaining because of fear of losing their jobs.

As over 60 per cent of mining costs are for labor, the most vital problem in mine management is the reduction of labor cost per unit of output, or in other words, the increase in human productiveness.

The success of many mining operations depends upon the attitude of the workmen toward their employer and their willingness to work well. The importance of such an attitude is evident. Under present conditions there are perhaps few places filled by unwilling workers.

The following table shows primarily the percentage of underground mining costs for labor classified according to the mining method used; the man-hours per ton mined have been added for purposes of comparison:

	Number of mines	Mining cost for labor per cent of total[1]	Number of mines[2]	Man-hours per ton mined[2]
Square set	12	65.4	61	5.15
Cut-and-fill	8	62.2	21	4.34
Shrinkage	16	61.7	37	1.33
Open stope	18	64.2	170	1.17
Sublevel Caving	3	65.5	17	.95
Top-slicing	3	59.8	37	.93
Caving	4	60.7	7	.63

1 - These are average percentages from the Bureau of Mines Information Circulars on mining methods and costs. The total labor cost includes the cost of supervision chargeable to mining, which is from 2 to 3 per cent of the total mining cost.

2 - Figures taken from Information Circular 6503.

While improved technology is an aid to reduction of mining costs, the ability of the management to devise ways and means of encouraging labor to accomplish more per hour without reducing wages is of greater importance.

In the following pages there has been brought together material regarding labor for the manager of the somewhat isolated mine to think over. Although many of the statements are self-evident, it is hoped there will be found ideas that will be useful in making his organization a more efficient and happy one.

GENERAL STATEMENT ON ORGANIZATION

Ideal organizations where all employees are endeavoring to promote the company's interests are rare. This leaves much to be achieved by proper leadership. To attain leadership in the handling of employees a mine manager must be a student of human nature; must have tact in dealing with personnel problems, both with the staff and with the workmen; must take an interest in everyone, including the workmen's families; and in certain instances must be a sort of father confessee whose judgment and fairness is the gospel of the colony.

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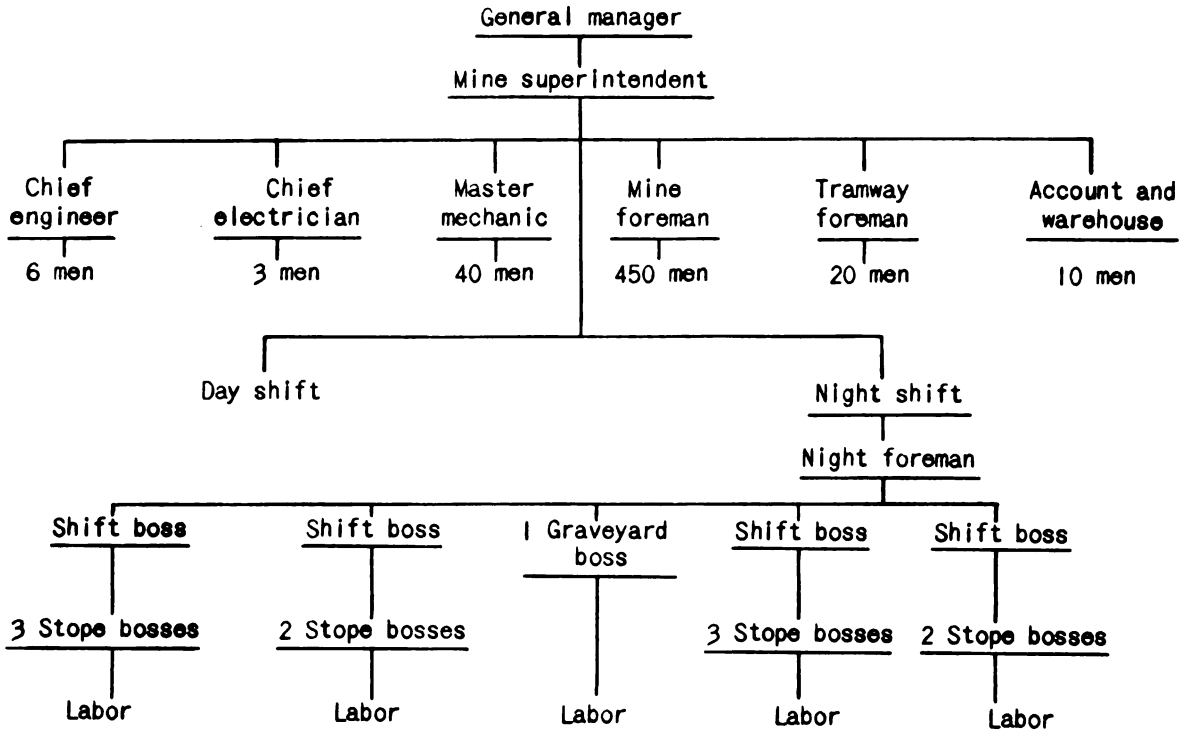

Figure 1.- Organization chart of the Pecos mine of the American Metal Co. of New Mexico

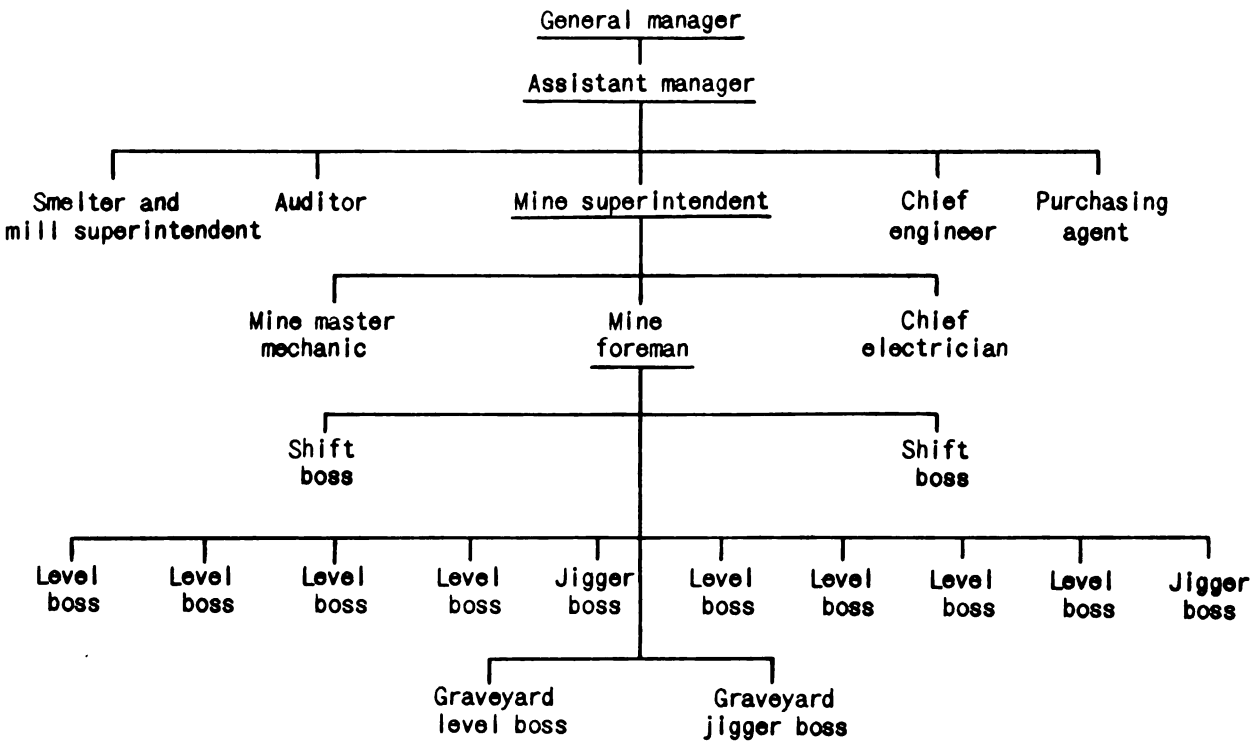

Figure 2.- Organization chart at the Magma Copper mine, Arizona

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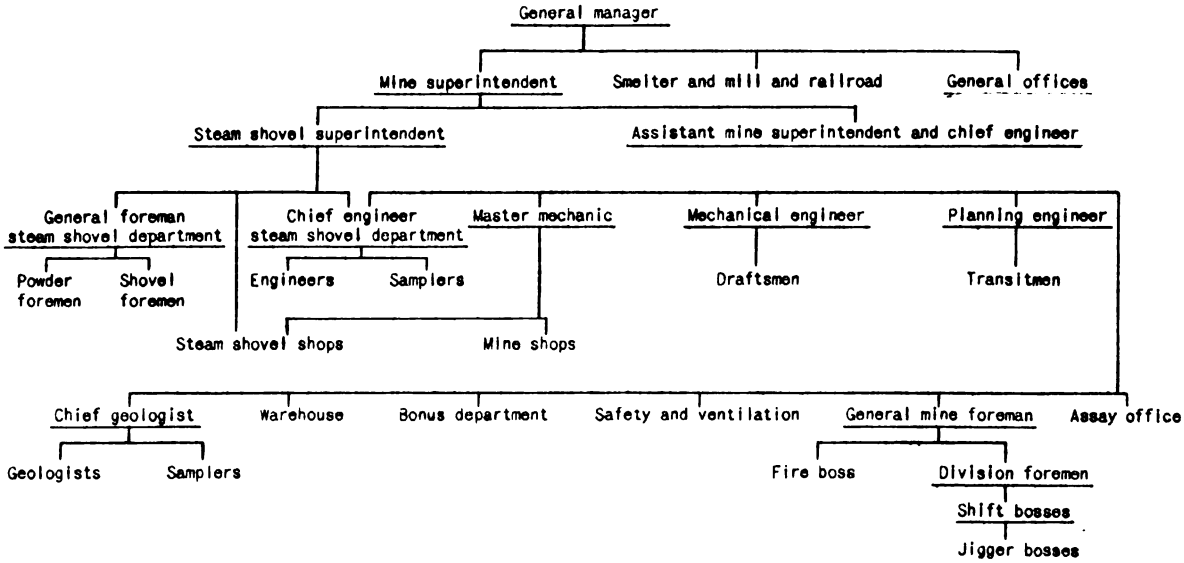

Figure 3.- Organization chart of the United Verde Copper Co., Arizona

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The mine manager must have the ability to help his staff in solving their daily problems and to inspire them to use their best efforts and their ingenuity at all times in the accomplishment of their tasks, giving full credit to them for any constructive ideas they present which may be of value to the work.

One of the greatest problems in any organization is to forestall the development of friction and jealousy, not only among the workmen but between the members of the staff as well. This job of keeping peace among the employees is often the manager's most difficult problem and it is only through personal contacts with his employees that he is able to learn about the causes of such friction and to find a way to eliminate them. A few reliable men on the staff who are not afraid to tell the manager, himself, when they believe him to be in error as to decisions and who are ready to interpret the real feelings of the employees as to questions of the company's policy, will often save the manager and company from situations that might become serious. This does not mean that a manager should employ secret informers, which practice is not advisable, but he should recognize men of good will and capacity who have a sincere regard for the interests of the company.

ORGANIZATION CHARTS

To indicate how certain medium and large-sized mining companies distribute responsibility, organization charts are shown in Figures 1,[3] 2,[4] 3,[5] and 4[6].

There are about 500 men in the Magma mine, supervised as follows: 250 men under each shift boss, 30 to 40 men under each level boss, and 15 to 20 men under each jigger boss. The shift boss is directly in charge of the mine, and might be considered a swing foreman in other mines. The level boss is in charge of all work on a level or part of a level. Jigger bosses are used on special jobs in comparatively isolated sections of the mine, such as where waste filling is being done, and also on haulage.

RESPONSIBILITY

The detail of control falls on the shoulders of those in active charge of the mine operations who are given full authority within their own spheres. They must answer to the general manager for the results of their work and must cooperate with the manager in correlating the work of their departments with that of the other departments. At the larger mines the mine superintendent appoints his assistants, foremen, and shift bosses, and requisitions for labor supply are sent through him to the mine employment office, but he and his staff should be permitted to act personally in respect to dismissals. At the smaller mines, the superintendent or foremen usually do the hiring personally. Orders should be issued through the officials immediately in charge of the workmen, and the responsibility of such official should be clearly recognized. The foremen and shift bosses must be reasonably assured that their superiors will support their actions and that their authority will not be questioned or decisions reversed in the presence of the workmen.

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3 - Matson, J. T., and Hoag, C., Mining Practice at the Pecos Mine of the American Metal Co., of New Mexico: Inf. Circ. 6368, Bureau of Mines, 1930, 21 pp. Fig. 18.

4 - Snow, F. W., Mining Methods and Costs at the Magma Mine, Superior, Ariz.: Inf. Cir. 6168, Bureau of Mines, 1929, 32 pp.

5 - Quayle, T. W., Mining Methods and Practices at the United Verde Copper Mines, Jerome, Ariz.: Inf. Circ. 6440 Bureau of Mines, 1931, 31 pp.

6 - Thomas, R. W., Mining Practice at Ray Mines, Nevada Consolidated Copper Co., Ray, Ariz.: Inf. Cir. 6167, Bureau of Mines, 1929, 27 pp.

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Experience shows that years are required to build up a stable and effective force of engineers and workmen, so that there is a great need for continuity of employment. An experienced foreman can be discharged overnight, but to replace an efficient foreman requires months. It is therefore advisable to maintain a well-trained small staff which is perhaps less than could be used in prosperous times and more than is essential during periods of industrial stress, but which approximates that necessary for average operation over long periods. In this way, the men feel secure in their jobs, and are not hampered in their efficiency and creative effort by the ominous thought of unemployment.

SUBDIVISIONS OF SUPERVISION

For the purpose of supervision certain mines are divided into one or more subdivisions with a foreman in charge, and each subdivision has several sections, each supervised by a shift boss who is usually in direct charge of from 20 to 50 workmen. These workmen are divided into groups for specific operations such as drilling, loading, and tramming.

Another system used in some of the larger mines is to detail the shift bosses to supervise a specific underground operation such as development, stoping, drawing of ore from chutes, operations on the grizzly levels, or haulage. It has been found that this system is more effective, especially in those mines where the main operations are paid for on a contract basis.

CONFERENCES AND PREPLANNING OF WORK

The efficiency of labor at a mine depends in large measure upon detailed preplanning for the operations which each group of workmen is to perform, and in the pulling together of each group, or the coordination of their efforts, in speeding up the work. To do this effectively each group of workmen must be given detailed instructions by the shift boss as to the work they are to do each day and as to how they are to cooperate with the other groups.

Many workmen have good thinking caps and they should be encouraged to use them. The wise shift boss will get the men under him to express their ideas as to the ways and means of doing the work and will pass on to his superiors any suggestions that will improve methods of operation, at the same time giving credit to the workman offering the suggestion. The engineers depend somewhat on the foremen for such suggestions and ideas about the work and they in turn pass them on to the mine superintendent.

At some mines the manager or mine superintendent has a daily or weekly conference with the engineers, foremen, and shift bosses to discuss past results and mistakes that have been made, also to get suggestions that might improve the results. If these men, responsible for the work in the different sections of the mine and surface plant, show a generous spirit of cooperation and bring with them constructive ideas for discussion, these conferences are a real benefit, as they tend to unite the operating staff in concerted effort and make each individual feel more keenly his responsibility in the organization.

In order to assure the employees that their ideas will receive recognition and that they will get some credit for them, certain companies keep a box for suggestions, and the employee whose proposals are considered of value is given a week's extra pay or some other compensation, as well as public recognition.

THOSE WHO GIVE ORDERS AND THEIR ATTITUDE TOWARD THE WORKMEN

The men who give orders and are in direct contact with the workmen are the foremen and shift bosses, and it is their duty to see that orders are carried out. The most successful

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boss is one who appreciates the difficulties and dangers that underground labor is subjected to and tries to help his men in every way possible. He does not drive when he should lead. Good bossing is a compromise between personal force and diplomacy. Workmen respect a boss who is a hard pusher if he is firm in his dealings and absolutely just. To win their loyalty the boss should take a personal interest in the men under him, know them by name, and see that they make good wages by showing them better ways to do their work.

THOSE WHO CARRY OUT ORDERS

Selection and Grouping of Personnel.- The success of any mine organization depends in a large degree on the efficiency of the workmen, who, as a class, have an innate tendency toward inefficiency and who, unless there is effective supervision or an incentive to work hard, will render as small an output as they can and still retain their jobs.

In selecting workmen it is nearly as important to do so on a basis of their fitness for each particular job as it is to engage a mine superintendent or engineer according to his merits. Some mining companies have an employment office through which requisitions for labor are filled, but the right to dismiss a workman is usually left to the mine superintendent or foreman. Certain mines give a special course of training to new men in the operation of rock drills or other machines and the shift bosses are instructed to spend some time where necessary in teaching the workmen how to do better work.

In many mines the workmen are grouped according to their task into squads of drillers, trammers, shovelers, timbermen, etc. These squads are detailed to certain stopes or mine levels and a close control is kept on the amount of work they accomplish. Charts are often kept to show these results and competition is thus developed between the squads and the shift bosses in charge of them.

It is the duty of the foreman or boss to determine whether a workman is worth his wage by comparing his work with the average performance of the other workmen. If there are poor men in a crew they should be supplanted as soon as possible by better men.

At some mines there is a periodic review by the management of all the employees, and this frequent survey of personnel as to ability and loyalty is found to be effective in maintaining a high degree of efficiency in the organization.

In cases where it is necessary for any reason to dismiss an employee, this should be done with a sympathetic understanding and a mind free from prejudice. Where necessary, helpful advice as well as reasonable money payments should be given if these are justified.

Machines, Tools, and Supplies.- As the continuity of operations depends upon the conditions of the machines in use, such as machine drills, scraper hoists, and haulage locomotives and cars, and on the availability of supplies, particularly drill steel and powder, pipe-repair outfits, timber, and tools, it is important that the shift boss or foreman does not overlook any of these details. He must see that machines, tools, and supplies are available when required. Good workmen soon become discouraged if they cannot have proper tools to work with and if their work is handicapped because of delays in getting tools and supplies due to lack of forethought by their superiors.

As a protection against theft or loss some companies sell the small working tools and lamps to the workmen at cost price and repurchase them if returned in good condition. The machine drills and other equipment are issued against a requisition signed by the worker's immediate boss.

Handling of Grievances and Discipline Cases.- At every mine complaints arise over questions of money earned, store deductions, working conditions in the mine, and living conditions. Often at the larger mines an officer is detailed to handle these complaints, and the mine bosses should give every aid to determine whether the complaint is just and to see that the workman is satisfied.

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PAY SYSTEMS

General Use.- Among mine operators there are those who still believe that a straight day's wage with proper supervision is the best system, while others are convinced that wherever possible work should be done by contract.

A general survey of the pay systems in use is therefore of primary importance. The Bureau of Mines has issued a series of Information Circulars on mining methods and costs, and in most of them there is a brief description of how the pay systems are applied. There are about 80 of these papers, prepared by the mine superintendents or engineers, and from these circulars the mines have been grouped according to their pay system with the names of the principal mines where each system is being used. The result shows that -

16 per cent of the mines described were on a day's wage basis:
(Mines — Utah Copper: Chino (New Mexico); Consolidated Cortez (Nevada); Kirkland Lake (Ontario); Tintic Standard (Utah); Central Eureka (California); Argonaut (California); Black Butte (Oregon); Nevada-Massachusetts (Nevada.)

8 per cent were on day's wage basis except mucking, which is done on a piece-work basis:
(Mines in Tri-State district.)

18 per cent did development work on contract and all other work on day's wage basis:
(Mines — Morning (Idaho); Engels (California); Pecos (New Mexico); Silver King (Utah); Page (Idaho); Groundhog (New Mexico); New Idria (California); Porcupine United, Vipond, and most gold mines in Ontario.)

18 per cent did development work on contract and other work partly on contract or bonus system and partly on day's wage basis:
(Mines — Morenci (Arizona); Burra-Burra (Tennessee); Old Dominion (Arizona); Magma (Arizona); Cananea Consolidated (Mexico); Campbell (Arizona); Park Utah (Utah); Montreal (Michigan); Rosiclare (Illinois); Spring Hill (Montana); and others.)

40 per cent did practically all work on a contract or bonus system:
(Mines — Mineville (New York); Alaska-Juneau (Alaska); Braden (Chile); Matahambre (Cuba); Marquette iron district (Michigan); Pilares (Mexico); Champion copper (Michigan); Edwards (New York); Mount Hope (New Jersey.)

Day's Pay.- When anyone pays a man by the hour or day, he buys human energy, but the workman does not always deliver the full amount paid for. The day-wage system encourages a man to withhold energy. He may work hard when the boss is present but will slack off and loaf when unobserved. This system encourages the boss to drive the man regardless of humanitarian, considerations.

It will be noted that the large open-cut mines, such as Utah Copper and Chino, are on a day-wage basis. At these mines the work is so organized and supervised that the men are required to accomplish just so much work within a specific time and a workman who can not keep up to the standard loses out. The ore cars must be loaded and ready for the trains on scheduled time. Adequate supervision is more easily accomplished in open-pit work than underground.

Piecework Systems.- Any contract or bonus system should function to the benefit of both employer and employee and should provide an incentive for the attainment of both quantity and quality of work and economy in the use of supplies. Carefully determined standards upon which a contract price or payment of bonus is based are essential for the success of these pay systems.

In nearly all of the systems, other than the leasing system, the workman is guaranteed his daily wage; the plan is to share profits, but not losses. He is not, however, guaranteed continuous employment should he fail to reach the standard of performance desired.

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To make a man's earnings depend upon his proficiency elevates rather than lowers him in the industrial scale. To impose a tacit penalty for inefficiency dignifies those who are efficient and gradually eliminates the unfit. A continuous record of the efficiency of each man gives essential information to the manager, whereas a series of such records helps to indicate the degree of efficiency on the part of the management.

With each system, a variety of definite compensation scales is possible.

Contract System.- As employed in mines of the United States, the contract system is the method of payment whereby the miners are paid a set price per unit of work performed but are usually guaranteed the prevailing rate of wages should their earnings at the contract price fall below the wage rate. Contract prices are usually set at the beginning of each pay period, at so much per foot of drift, raise, crosscut, shaft or winze; per ton, per cubic foot, or per car of ore, or per foot of hole drilled; per set of timber placed, etc. The mining company usually furnishes all tools and all materials except possibly explosives. The contract prices are varied to suit conditions, taking into consideration the character of the ground, its "drillability" and "breakability" and requirements for support, and other factors influencing the difficulty of the work. In mining, these conditions are apt to vary widely in different parts of the mine and to change suddenly from point to point in the same section.

This system is aimed to reward the more able and energetic workman for his skill and added effort to promote efficiency, and if properly applied it usually produces these results.

Among the disadvantages of the contract system are:

(1) Increased earnings for the contractor may result from a sudden favorable change in conditions during the pay period, without any added effort or unusual skill on his part, and the company may then pay at the set price a greater amount than would be paid on a straight day's-pay basis.

(2) Contract prices may be changed frequently as conditions change, but a reduction in price during the pay period is usually resented by the worker. Likewise, when a reduction in price is made at the end of a pay period, during which excessve earnings were made due to favorable conditions, the contractor often feels that these earnings were largely due to his skill and increased effort, and that under the new reduced rate his efficiency is being discriminated against.

(3) It is difficult tc set prices for different classes of work and for different working conditions which will fairly represent the difference in skill and energy required for the performance of each class of work. To reflect adequately the various conditions in the prices, frequently requires somewhat complicated computations which the average miner is not able to understand, in which case he will probably be suspicious that he is not receiving the remuneration he deserves.

(4) The company does not participate in money savings resulting from speed, except in reduced unit overhead charges.

(5) Supervision is difficult, as the contractor is inclined to do work of poor and unsafe quality in the attempt to make speed.

In spite of these disadvantages, the contract system usually results in more efficient work than does the day's-pay system, especially for certain tasks which can be more or less standardized, where conditions do not vary widely, and where the management is able to pick and train certain men to do specific kinds of work. Its use means that the company can figure on a definite labor cost for specific pieces of work (except when the contractor falls below standard), and can expect a maximum of speed in getting the work done.

Leasing System.- The leasing system as practiced at Cripple Creek and other western camps is in effect a true contract system. Under this system, the miner is given a certain block of ground to work, the proceeds from the sale of his ore being divided between the company and the lessee on a predetermined basis. The lessee furnishes all the labor, usually the

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explosives, and sometimes part of the tools. He receives no more than his share of the proceeds whether he makes wages or not.

Bonus System.- Under the individual bonus system, the miner is paid day's wages for the number of shifts worked. In addition he receives a bonus of so much per foot of heading driven, per ton or car of ore, etc., in excess of a prescribed standard performance which is usually taken as the average performance of a good workman under average conditions. The bonus is figured so that both the miner and the company benefit directly by units of work performed in excess of the standard task. The miners receive additional pay in the form of a lump sum, an additional number of shifts, or so much per shift extra, while the company gains additional units of work at less than the average cost and also a reduction in overhead (which also results from superior performance under the contract system).

The group-bonus system, based on group output, is one that can be readily introduced without friction, but there is not the incentive for each man to do his individual best, no reward for the better worker. The plan, however, does discourage any slackness on the part of the poor workers, as good workers will insist that all men do their share of the work.

The bonus system is frequently applied to gang work, where the men (and often their foreman as well) receive a bonus conditional upon the completion of the prescribed task within the standard time. The contract system, found in large mines, frequently involves either a gang piece rate or a gang bonus. A contract rate may be accompanied by piece work or bonus rates for the men working under the contractor; or the men may be straight day workers, having no share in the profits which the contractor derives from their labor.

Methods of Determining Contract Price or Bonus.- Each mine superintendent has to work out a basis on which he can determine the price to pay for development work, stoping, loading, tramming or any operation to be let at contract or performed on a bonus basis. The best basis is to know average past results and then to pick the best men for the work and arrange a contract with them or to institute competitive bidding among the mine contractors. In some instances time studies are made as an aid in determining the price to be paid for the various operations, but they are often misleading and good workmen object to having a man with a stop watch keeping time on their work.

Certain of the large mines employ contract or bonus engineers who decide the amount to be paid for a specific amount of work, while others have an efficiency engineer who studies the ways and means for improvement and advises the foremen in regard to these and also in reference to contract prices or bonus payments.

GENERAL PRACTICE IN PAYING LABOR IN THE PRINCIPAL MINING DISTRICTS

Mineville, New York.- The pay system in use at the Mineville magnetite mines is described by A. M. Cummings, mine manager, as follows:[7]

> At the Witherbee, Sherman & Co.'s mines the wage is based on an hourly rate.
>
> For 1927 the schedule as applied to the important classifications was as follows:

7 - Cummings, A. M., Methods and Cost of Mining Magnetite in the Mineville District, New York: Inf. Cir 6092, Bureau of Mines, 1928 pp. 10-11.

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	Per Hour
Trammers	$0.32
Drill runners	.36
Hoistmen and locomotive operators	.34
Carpenters and repairmen	.40
Foreman and roofman	.41
Shift foreman	.45

A premium is paid all classes of labor. This premium is based on the hand cars loaded and trammed and the tons broken per man drilling.

Tramming.- Twenty-eight cents per car is paid to the men who load and tram 10 cars per shift, 29 cents per car for 11 cars and 30 cents per car for 12 cars and over. Men tramming less than 10 cars per shift receive the base rate of 32 cents per hour or $2.56 per shift.

The tram cars have a capacity of 1½ tons of the richest ore when completely filled, but due to the different grades of ore, an average of 1 ton per car is obtained.

Drilling.- An average of 30 tons per man drilling for a period of one month for all men engaged in drilling is the basis of the drilling premium. Fourteen cents per ton for the average tons per man drilling is paid each man engaged in drilling. When the average of the tons per man drilling falls below 30 tons, the men receive the base rate of 36 cents per hour, or $2.88 per shift.

The difference between the hourly rate of $2.88 per shift for drill runners and the amount earned at 14 cents per ton is the premium. This premium is given to all other classifications, including the mine captains, with the exception of the trammers, in addition to their regular hourly rates.

As far as possible the system described is made to apply to all conditions, but there are exceptions in both tramming and drilling work which make adjustments necessary in order that compensation for the work may be more comparable to the rate for average conditions.

In some of the sinks and long headings, special arrangements are made as to the number of cars required for a day's work. To make their earnings per shift higher extra hours are given the drill runners when in difficult places requiring the most experienced men. Extra hours are also given to those who assist in blasting. The hoistman and electric locomotive operators receive extra hours when the hoisting extends beyond the regular 8-hour shift.

This is a true bonus system, and it has the added feature, rather unique among mining companies, of being based upon group performance rather than individual output (except for tramming). The daily output is posted at the shaft so that the workmen know the results of their work as well as the bonus they will receive each day.

Edwards, New York.- The systems of payment at the Edwards lead-zinc mine have been described briefly as follows:[8]

All underground work except maintenance and repairs; installing chutes, track, and pipe; loading and hoisting in the shaft; some tramming; pumping and warehousing; and supervision is done on a contract basis with minimum wages guaranteed.

8 - Knaebel, John B., Mining Practice at the Edwards Mine of the St. Joseph Lead Co., St. Lawrence County, New York: Inf. Cir. 6586, Bureau of Mines, 1932, p. 21.

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Development contracts are paid on a footage basis. In lateral work the contract includes every operation except laying track and pipes; in raises it covers breaking only, and the ore is drawn and trammed on a separate contract or on company account.

Stope contracts are all paid on a tonnage basis, computed from the cars and average load per car trammed each shift. Tonnage hoisted per shift is determined by weighing at the mill head, and a record of the cars hoisted provides the data for prorating the tonnage from each stope. A few stopes are measured by the engineers to determine the tonnage mined, in cases where the ore is mixed in ore passes with material from other sources. Shrinkage-stope contractors are paid for three times the tonnage drawn.

Tramming and motor-haulage contracts are paid on a flat tonnage basis. Allowance is sometimes made for long trams on development contracts.

Bosses receive no production bonuses.

Sanitary contracts, which involve removal of the portable toilets from each level for weekly cleaning on the surface, are paid a flat rate on the basis of 5 hours per job.

Chutes, track and pipe installations, repair work, and similar odd jobs are done by a regular repair crew on company time.

Ore hoisting is on company account.

Contractors buy powder, caps, and fuse; other supplies are furnished by the company.

Lake Superior Iron Mines.- Most of the eight mines described in information circulars employ a "contract" system (based usually on cars of ore, but sometimes on footage driven in development) for practically all underground work; one uses "contracts" per foot for development and a 10 per cent bonus over day's pay for extra work in stoping. Wages are guaranteed. Day's pay is used for some maintenance and repair work.

The following excerpts from papers on underground mining on the Mesabi range of Minnesota and the Marquette range of Michigan are fairly typical of practice in those districts. According to Hazelton:[9]

Practically all the ore is mined by contract. Each contract rate is established by the superintendent and mining captain, and the men are advised of the rate at the beginning of the month. No change is made in the rate during the month unless it is obvious that it is too low. If it is too high the men benefit by it. At the beginning of the next month different rates may be established. The men have been convinced that they will get a square deal and are willing to work the last few days of the month just as hard as they do during the early part. The rate paid is set high enough to include the cost of powder and other miscellaneous supplies except timber, as these items are charged by the powderman to the contract in question. The foregoing plan is for mining places. Footage contracts are used for drifting and raising gangs. Only a few gangs of miners work on 'company account' and then only under some unusual condition making it impossible to set a fair contract rate. Contract miners are never paid less than the established company account rate.

9 - Hazelton, W. D., Underground Mining Practice and Costs at a Mesabi Range (Minnesota) Mine Using the Top-slicing System: Inf. Cir. 6325, Bureau of Mines, 1930, p. 9.

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Graff[10] summarizes the usual Marquette method of paying labor in the following terms:

> All miners work on a contract system, the unit price calculation being a 4-ton main-level tramcar. Every contract in the mine is provided with a scraper, and the contract price per car ranges from $1.10 to $1.80. A few gangs of timbermen are employed on the company-account system of pay. The miners pay for explosives, carbide lamps, and other small supplies. The company furnishes drill machines, drill steel, compressed air, electricity, loading equipment, and timber The miners do their own drilling, blasting, timbering, and mucking.

Michigan Copper Mines.- The contract system used at the Champion mine is described by Albert Mendelsohn,[11] as follows:

> With the exception of repair and maintenance gangs all men in the mine work on contract. About 71 per cent of the men on the underground pay roll make money on their contracts; the average pay per contractor is about 50 cents per shift above the "company-account" base.
>
> Shaft sinking is paid for at a set price per foot sunk and covers mining, mucking, and timbering labor. Up to a limited number of pounds per foot sunk, powder is free; all powder used above that limit is paid for at cost by the contractors.
>
> Drifting is paid for at a set price per foot of advance, the price varying for each different width of drift and covering labor of mining, mucking, and disposing of rock. Up to a limited number of pounds per foot of advance, powder is free, the amount allowed varying with each different width of drift; any excess powder is paid for at cost by the contractors.
>
> Because hand sorting is practiced in the mine the stoping contracts are somewhat more complicated than the development contracts. Barren rock must be kept out of the copper cars, and copper rock must not be discarded as waste. The rule given to pickers is simple: Large pieces of rock containing any copper whatsoever that can be seen must be shipped as copper rock; fine rock must be shipped as copper rock unless ordered left in the stope by the boss. Cars of copper rock are inspected by the bosses and by a poor-rock inspector. Discard in the stopes is inspected by the bosses and the captain.
>
> In the stopes the contract system is balanced in such a way that the best pay will be made by those contractors who carefully sort their rock. The organization in a stope consists of a miner and one or two pickers on each shift. The miners' company-account rate is 45 cents a day above the pickers' company-account rate. These men mine, pick, and do all the propping necessary in their stope. Each participates in the bonus earned for the month in proportion to the number of shifts he has worked. Engineers measure monthly the volume of the excavation made in each stope to determine the total rock broken in each stope and the average width of the stope. Underground records show the number of cars of copper rock shipped from each stope. The time books show the number of shifts of all labor working in each stope. From these data the engineers calculate monthly the bonus to be paid to each party of contractors.

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10 - Graff, W. W., Mining Practices, Methods, and Costs at Mine No. 5 of the Marquette Range, Michigan: Inf. Cir. 6380, Bureau of Mines, 1930, p. 7.

11 - Mendelsohn, Albert, Mining Methods and Costs at the Champion Copper Mine, Painesdale, Mich.: Inf. Cir. 6515, 1931, pp. 11 and 12.

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The use of three tabulated rate schedules facilitates the work of calculation. The rate schedules cover:

1. The bonus per shift to be paid for a given tonnage of rock broken in a stope of a given width; the wider the stope, the greater the tonnage broken per man per shift for a given bonus.
2. The bonus per shift for a given tonnage of copper rock produced, after sorting, from a stope showing a given ratio of total broken to total copper rock produced; the greater the amount of barren rock that must be handled in sorting, the greater the bonus pay per shift for a given tonnage of copper rock produced.
3. The allowance of powder per ton of rock broken for each width of stope.

Ducktown, Tennessee.- The following description by McNaughton[12] illustrates briefly the application of the contract system at the Ducktown copper mines:

General.- All development work, with the single exception of the long crosscut to the Eureka mine, is driven on contract. The blocking (blockholing) and loading are partly done on contract and partly on day's pay. Thirty-nine per cent of the total shifts under this classification in 1928 were paid on the contract basis. Thirty per cent of all stope drilling was done on contract. All other mine labor was paid according to standard daily wage rates for each classification of labor.

Development.- Drillers in standard 8 by 8 foot drifts receive a price of $5.50 per foot with a 50-cent variation either way for very hard or very soft ground. The ground classification is determined at the end of each pay period by the mine engineer, who is himself an experienced drill runner. The company pays for mucking these headings in the manner described later under "loading."

The sublevel drifts are contracted at the following rates:

$6 per foot for the first 50 feet from dump point.

$6.50 per foot for distances of 50 to 150 feet from dump. Fifty cents is added to or taken from these prices for hard and soft ground, respectively. The prices named cover drilling and mucking labor and dynamite. The drillers receive 60 per cent and the muckers 40 per cent of the net earnings.

For raises driven by two men, which is the usual practice, the price per foot ranges from $5.25 for the first 25 feet above the level to $8.50 per foot for distances 200 feet or more from the level. Price changes are made every 25 feet. A 25-cent variation from these prices is made for hard and soft ground.

Stoping.- Drilling in stopes is contracted at a price of 7 to 10 cents per foot of hole drilled; the price is varied according to the hardness of the ground The price is fixed for each stope and is altered only occasionally as conditions change.

Loading.- Loading includes blockholing on grizzlies, loading cars from grizzlies, and hand-loading from drifts, stopes, and robbing. The men employed on this work are shifted from one job to another as occasion demands. Payment is made on a per-ton basis; the tonnage is figured from the car count.

12 - McNaughton, C. G., Mining Methods of the Tennessee Copper Co., Ducktown, Tenn.: Inf. Cir. 6149, Bureau of Mines, 1929, pp. 13-14.

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Prices paid range from 4 to 30 cents per ton, depending upon the loading method, amount of blockholing required, and car service.

Labor for blocking and loading from grizzlies is paid for at the rate of 4 to 7 cents per ton. The 7-cent rate was paid at the first grizzlies installed, where storage was provided below the grizzly and the ore had to be pulled through a chute. On account of the blocky nature of the ore it tended to wedge in the chute, and almost as much labor was required to pull the chute as to block the ore through the grizzly.

Hand loading from development drifts is paid for at rates varying from 20 to 30 cents per ton, depending upon the material handled (waste or ore) and length of hand tram.

The actual price paid for loading is set for each job and place upon recommendation of the mine foreman and authorization by the superintendent.

Company rates and contractor's average earnings for principal classifications, 1928

Classification	Company rate per shift	Actual contract earnings per shift
1. Drillers:		
a. Development	$3.92	$7.17
b. Stoping	3.92	6.06
2. Trammers (loading)	3.60	4.97
3. Timbermen	3.72	-
4. Motormen	3.92	-
5. Skip conductors	4.88	-
6. Hoist engineers	4.88	-

Mascot, Tennessee.- At the Mascot zinc mines, large contracts are let in much the same manner as at Alaska-Juneau. Coy[13] states in part:

Wherever applicable contracting is in effect. Some miscellaneous work of such a nature that it can not very well be contracted for is carried on company time. However, bonuses apply to all company-time work, as will be explained later in this paper.

The mill-hole contractor agrees to break and deliver ore into cars at a stipulated price per ton. The company furnishes drills, drill steel, and power; the contractor furnishes labor and explosives. The chute pullers in turn contract with the mill-hole contractor to draw his ore into cars at a price per ton. Settlement is made with the mill-hole contractor each week; all labor, including his chute pulling, and explosive costs are deducted, and the balance earned on the contract is paid him. An itemized statement of his account is furnished him each week.

Contracts in open stopes cover merely breaking and apply only to tonnage made available to shoveling tracks. Open-stope contractors are required to do all blocking for shovelers and to assist them in keeping their working place in good condition.

13 - Coy, Harley A., Mining Methods and Costs, American Zinc Co. of Tennessee, Mascot, Tenn.: Inf. Circ. 6239, Bureau of Mines, 1930, pp. 7-8.

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The contracts carry no guarantee as to earnings. Modifications of contracts are made when, in the judgment of the management, conditions beyond the contractor's control justify change. As a guarantee of the faithful performance of the contract, a holdback of 30 per cent is retained by the company until a definite amount has been set up. This holdback is payable to the contractor only upon termination of the contract.

Contractors are responsible for secure roof conditions in their working places. If it becomes necessary, through negligence on the part of the contractor, for the company to do this work, deductions are made from this holdback to cover such expense.

Although most contractors pay their drillmen and helpers company-scale wages they have the privilege of increasing the compensation received by such men. The company sets a limit to the increase. Any such increased pay becomes a part of the contractor's costs and is deducted on his settlement sheets; hence, he tends to make such increases sparingly. The system, however, allows the contractor to give recognization where it is deserved.

Development contracts are based upon footage of advance per week. In most instances a definite distance to be driven is specified in such contracts. Usually both men are drillmen. Settlements are made each week, and their earnings are proportioned to the number of shifts each has worked during the week.

Slushing contracts cover breaking, dragging, and chute pulling. Payments are made on a tonnage basis, as in other contracts. The contractor supplies all labor and explosives and takes care of all blocking, cable splicing, and hoist repairing.

Motormen and motor couplers participate, in proportion to their earnings, in a bonus based upon the total weekly tonnage handled. Skip tenders and helpers participate in a like bonus.

The day-shift mine foremen participate in a monthly bonus based upon the monthly production of 60 per cent zinc concentrates. As the night shift is principally a chute pulling and shoveling shift the night-shift foreman's bonus is based upon total tonnage hoisted.

Tri-State District.- Most operations at the lead-zinc mines of this district are on day's pay, except shoveling, which is paid for at a fixed rate per "can" loaded. Some pull drifts and some shafts are driven on "contract" per foot. Day's pay is determined by a sliding scale based on a price of $40 per ton for zinc concentrates.

Netzeband[14] makes the following comments on the pay system used at one mine in the district:

All labor, except mucking, is based on an 8-hour day. Muckers are paid on contract, 11 cents per can of 0.6 ton on the main level and 14 cents per can on the lower level. The bonus is paid to men employed on the lower level because the ventilation is poorer and they can not compete on an even basis with the men on the main level. The following wage scale was in effect during 1928 when zinc ore prices stayed at $40 or under for prime western ore.

14 - Netzeband, Wm. F., Method and Cost of Mining Zinc and Lead at Mine No. 2, Tri-State District, Picher, Okla.: Inf. Circ. 6121, Bureau of Mines, 1929, p. 9.

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Machine runners	$4.25
Machine helpers	3.75
Trammers and drivers	3.50
Hoistmen	4.75
Powdermen	4.50
Roof trimmers	4.00
Screenmen	3.50

This wage scale is based on $40 zinc ore. If the price goes to $45 and stays there for one week, all wages are automatically raised 25 cents per shift, and muckers are raised ½ cent per can. In the same manner, for every $5 raise in the price of zinc ore above $45 the wages are raised at the same rate, but for every drop of $5 the wages are reduced. Wages are not reduced when the ore price drops below $40, for this is the base price for the wage scale. A week is always allowed between the wage changes to make sure that the market will not fluctuate above or below the critical price.

An average experienced mucker will load 40 or more cans in an 8-hour shift. There are several men at the mine who will average 100 cans per shift, but they are exceptional men and are usually given the best working places.

This may be regarded as fairly typical practice in the district. Contract rates for mucking vary considerably at different mines, however, due to variations in underground conditions.

Southeastern Missouri.- At the two lead mines described in information circulars, all work is on "contract" per foot or per ton (with hoveling on bonus for work exceeding 20 tons per shift at one of them).

Details of contract rates prevailing in 1929 are given by Poston[15] as follows:

All mining operations at No. 8 mine are conducted on day shift only. The standard day is from 7 a.m. to 3.30 p.m., with 30 minutes for lunch, which is eaten underground.

Base rates for various operations and for an 8-hour day are as follows:

Shift boss	$5.95
Assistant shift boss	5.35
Mechanical shovel operator	5.80
Company driller	5.05
Motorman	5.05
Hoisting engineer	5.05
Skip loader	5.05
Hand shoveler (minimum of 18 tons)	5.00
Railroader	5.00
Pumpman	5.00
Switchman	5.00
Pipe fitter	5.00
General underground labor	5.00
General surface labor	3.85

15 - Poston, Roy H., Method and Cost of Mining at No. 8 Mine, St. Louis Smelting & Refining Co., Southeast Missouri District: Inf. Circ. 6160, Bureau of Mines, 1929, pp. 15-16.

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The rate of $5.80 for mechanical shovel operator applies only when conditions for mechanical loading are adverse. The operator usually receives 8 cents per ton, and if the earnings at this rate exceed $60 per week, half of this excess is turned back to the company. This refund feature does not apply to the hand shovelers, who retain all they may earn under the following schedule:

Contract hand shovelers receive $5.00 for loading 21 tons, 5.55 for loading 22 tons, and 0.28 for each additional ton above 22 tons.

Company hand shovelers receive $5.00 for loading 18 tons, and 4.50 for loading less than 18 tons, provided the total is approved by the shift boss.

The shift boss's approval simply indicates that conditions were so unfavorable that the required 18 tons could not be loaded.

All breaking is done under a contract system. Each tonnage contractor is guaranteed the company rate of $5.05 per shift. This wage is seldom paid, however, for the contractors make more when paid on the following basis:

For stopes 8 feet or less in height, 14 cents per ton of rock broken.

For stopes from 8 to 20 feet in height, 13 cents per ton of rock broken.

For stopes more than 20 feet in height, 10½ cents per ton of rock broken.

The rates just quoted are for places where the rock is to be loaded by hand shovelers. When the rock is loaded by mechanical shovels the contractor receives 1 cent less per ton for all rock loaded.

The breaking and loading of all tonnage, exclusive of drift tonnage, is paid for according to actual underground scale weights and not by car units.

Drift contracts receive approximately $4.25 per foot of drift advance, from which is deducted a certain percentage of shovelers' labor necessary to remove the broken rock from the drift. Fifty per cent of the drift contractor's earnings in excess of $72 per week is refunded to the company. Fifty per cent of the tonnage contractor's earnings in excess of $60 per week is also refunded to the company.

Wages are paid weekly by check on each Wednesday for all time worked to 7 a.m. of the previous Sunday.

All employees must be ready for duty at 7 a.m., but the contract shovelers may leave the mine at any time after they have done the minimum amount of work required by the company. All other employees end their shift at 3.30 p.m.

Practice at another mine in this district is described by Jackson[16] in the following terms:

All men are guaranteed the basic daily wage ($5.05 per shift). Contracts are figured at the old unit prices, and the amount in excess of the old daily wage times the number of shifts work is added to the present basic wage rate times the number of shifts worked to calculate the total amount paid in each case. Eight hours constitutes a shift.

Drilling.- Drillers are paid a set price per foot of advance in development work and in stopes and stope headings for the number of tons broken, as measured by the number of 2½-ton cars loaded, recorded by car checkers employed for that purpose. Drillers furnish only their labor and powder, which is sold to them by the company at a fixed price somewhat lower than the actual cost price, while the

16 - Jackson, C. F., Methods of Mining Disseminated Lead Ore at a Mine in the Southeast Missouri District: Inf. Circ. 6170, Bureau of Mines, 1929, p 19.

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company furnishes drilling equipment, tools, and compressed air.

Prices for drifting, raising, and sinking vary with the character of the ground, size of excavation, and accessibility of the working place. The machinemen carry their own steel to and from the shaft, no 'nippers' being employed.

In stopes the unit price varies principally with the height of the stope, though character of ground, accessibility of the stope, etc., may be given consideration also. This price is 16 to 18 cents per ton in low ore and 12 to 14 cents in somewhat higher ore, to a minimum of 8 cents per ton in high stopes of "bluff mining."

Loading.- Prices for loading ore in stopes, whether by hand or mechanical loader, vary with the height of stope, tramming distance, and character of the work. Hand loaders tram their own cars and ordinarily use a mule for transferring cars between the loop and the muck pile. Ordinarily the mechanical shovel operators tram their own cars in the same manner, unless there is enough muck to warrant mule drivers being employed.

The usual task of "score," as it is termed for a hand mucker, is 20 tons, for loading which he receives only the regular daily wage. In excess of this he receives a bonus for each extra ton loaded. In places where there is a long tram hand tramming, or badly scattered muck, the score may be reduced to as little as 14 or 16 tons.

In development work it is customary to pay 8 to 10 or 12 hours for mucking out the round, depending upon the size of the excavation and loading conditions. Where the muck is all in one pile, as at the foot of a raise, and other conditions are normal only 8 hours are usually paid, while in driving a slope where loading is not so easy as in the drift, and where the muckers have to go up and down the slope to operate the hoist 12 hours would be the average pay.

Butte District, Montana.- A highly developed system of piecework, based on linear feet and cubic feet as the work requires, is used in most of the Butte copper mines. North Butte was one of the pioneers in developing standards for underground work. At Black Rock, the pay system used has been described by McGilvra and Healy[17] as follows:

> The wages paid at the Black Rock mine are the same as are paid throughout the camp. The wage scale fluctuates, and in the last 7 years the minimum daily wage paid underground was $4.75 and the maximum $6. The wage scale effective in the district in May, 1930, for the principal classifications of underground employees was as follows:

Hoist engineer (surface)	$6.50	
Miner	5.25	
Mucker	5.25	
Motorman	5.25	
Pumpman	6.00	
Pipeman	5.75	
Shaftman (sinking)	5.75	(contract work)
Shaftman (repair)	5.75	
Station tender	5.75	
Timberman	5.25	
Trammer	5.25	

17 - McGilvra, D. B., and Healy, A. J., Methods of Mining at the Black Rock Mine, Butte and Superior Mining Co., Butte District, Mont.: Inf. Circ. 6370, 1930, pp. 11-13.

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Practically all breaking, shoveling, and timbering operations are done on "contract," as the term is used. It is really a bonus system and not contract work, as the men are given a certain definite price for the work to be done and if they make more money than the day's-pay rate they are paid the extra money as a bonus at the end of the period. If the men fall below the day's-pay rate they are guaranteed a minimum daily wage, but the particular place is investigated to see whether the failure to make bonus is due to conditions or price.

The samplers who take daily samples underground also keep a close check on all contract work and carry notebook sketches with them at all times showing a plan view of the working place. Notes are made from time to time of the progress of the work. The engineering department staff also aids in the measurement of contracts. Contracts are measured and calculated twice per month, but the bonus is paid once per month.

Prices are set by the chief contract engineer, and all contracts are checked by him at the middle and end of each month. A large sheet is kept in the office on which a plan of the work being done is sketched, and all calculations are shown so that the miners themselves can see what has been paid.

The price for drifts is generally $7 per linear foot, an over-all price that includes breaking, shoveling, and tramming. All timbering is paid for separately at $5 for each set of timber.

All timber for contract work is trucked by the miners at a price ranging from $0.50 to $1.50 per set, depending on the distance and conditions.

Nearly all raises are paid for at the rate of $0.080 to $0.100 per cubic foot of completed raise. This price is split up into $0.050 to $0.085 per cubic foot for breaking, $0.015 to $0.020 per cubic foot for timbering, and $0.015 to $0.020 per cubic foot for lining chutes.

Stope contracts are paid at a price ranging from $0.065 to $0.100 per cubic foot. The price varies, depending upon whether the rock is handled by sliding, mucking and sorting, silling, or underhand stoping. The over all price is divided into prices ranging from $0.025 to $0.040 for breaking, $0.025 to $0.040 for shoveling, and $0.015 to $0.020 for timbering.

Other operations, such as stope filling, $3 to $6 per set; bulkheading, $5 to $10 per set; raising chutes and manways, $12 to $16 for chutes and manways; and tramming, $0.015 to $0.030 per cubic foot, are also on contract.

Shaft retimbering and removal of old shaft timbers are paid for at the rate of $14 to $20 per linear foot for removing old timber and putting in new.

The wide variation in prices depends on the hardness of the ground, method of handling ore, and general conditions at the working places.

The plan of making contracts where the men buy their own powder and are paid whatever they make without the guarantee of a minimum wage has been tried.

The bonus system now being used has been successful, and it is the best plan which has been tried thus far. If the rates are equitable and fairly uniform for similar work, the miner who understands his business is paid a premium for accomplishment.

Coeur d'Alene District, Idaho.- Three of the Idaho lead mines described in the Information Circulars give data on pay systems. At one, development is on "contract" with 5 per cent withheld until work is completed, to insure good work. The balance of the work is on day's pay.

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At the other two mines, the plan is similar, without any mention of 5 per cent retention. Day's pay rate is based on the price of lead.

According to Foreman:[18]

> The employees of the Hecla and Star mines are paid a base wage, plus a bonus which is dependent upon the price of lead for the preceding month.
>
> All stoping in the Hecla and Star mines is done on company account. Drifts in waste, crosscuts, and raises in ore or waste are generally contracted. No standard price is possible for contracts, due to changing conditions. A contract is given to the entire crew and earnings are divided in proportion to shifts worked. Contract calls for labor only, as explosives and other material are furnished by the company. Raises are also contracts, as previously shown.

At the Morning mine the pay system in use has been described by Wethered and Coady[19] as follows:

> All labor is based on an 8-hour day. Wages are uniform throughout the district and are based upon a sliding scale according to the price of lead. During 1928 when lead sold for 6 to 6½ cents a pound, wages were as follows:

	Per day
Miners	$5.00
Timbermen	5.50
Timbermen helpers	4.75
Muckers	4.50
Motormen	5.25
Motormen helpers	4.75
Shaftmen	6.00

> No contract or bonus system is employed in actual stoping operations. All work is paid for at day's pay according to the classification under which the work comes.
>
> Shaft-sinking, skip chutes, station-cutting, etc., are usually contracted for at so much a linear foot or cubic foot. The main development drifts on the levels are generally driven on day's pay plus a bonus for speed. Raises and crosscuts are contracted for at so much a linear foot.
>
> The mine superintendent has charge of all operations underground. His plans are carried out in detail by three foremen and a corps of shift bosses, none of whom shares in the contracts or participates in any bonuses.

Utah Lead-Silver Districts.- At the Park Utah mine the contract system is used for development work (including mucking, tramming, and timbering) and per set for stoping. Stope filling and miscellaneous work are on day's pay.

At Silver King, development is on "contract" per foot, and other work is on day's pay.

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18 - Foreman, Charles H., Mining Methods and Costs at the Hecla and Star Mines, Burke, Idaho: Inf Cir. 6232, 1930, pp. 17-18.

19 - Wethered, C. E., and Coady, Leo J., Mining Methods at the Morning Mine of the Federal Mining & Smelting Co., Mullan, Idaho: Inf. Cir. 6238, Bureau of Mines, 1930. pp. 9-10.

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At the Park Utah mine, according to Hewitt:[20]

The labor for the mine is composed largely of men who live in the nearby farming communities. About 60 per cent of the underground employees are native Americans, about 25 per cent naturalized Americans, and the remainder are of various European nationalities. Labor is efficient and does not constitute a serious problem. The labor turnover is very small.

The following is the wage scale in the district in August, 1929, for the principal classifications of underground employees:

Cage tender	$5.75
Hoistman underground	5.75
Miners	5.25
Motorman	2.25
Muckers	4.75
Nipper	5.25
Pipeman	5.25
Powderman	5.25
Pumpman	5.75
Scraper operators	5.25
Shaftman	7.00
Timberman	5.25
Trackman	5.75

Square-set stopes are contracted for at $9 to $12 per square-set, depending upon whether 6 or 8 men, equally divided on two shifts of eight hours each are employed on the contract. Contractors are required to drill, blast, stand and block timber, place mining floor, rig up scraper, and scrape ore into the chutes. Tramming may or may not be included in the contract. Filling of stope with waste is done on company account. Tools and supplies which are furnished by the company are brought to within convenient distances of the working places by company-account labor.

Cut-and-fill stopes are contracted at 5 cents to 7½ cents per cubic foot. A contract crew consists of six to eight men and is divided into two shifts. The contractors drill, blast, scrape ore into chutes, distribute waste filling, and lay blasting floor. Tramming may be included in the contract price.

Stull raises 5 by 8 feet in section are driven on contract at $2.50 to $3.50 per foot. A crew consists of two men, one man on each shift. The company furnishes a helper to assist the contractor in getting stulls up the raise. Pipe is put in on company account.

Untimbered drifts are driven on contract at $4 to $10 per foot. The variation in price is due to whether or not speed is essential and the working-conditions. If timbering is necessary, the contract crew receives from $5 to $6 per set in addition to their contract rate per foot. The contract crew does all the work necessary to advance the heading, with the exception of putting in the pipe and the track.

20 - Hewitt, E. A., Mining Methods and Costs at the Park Utah Mine, Park City, Utah: Inf. Cir. 6290, Bureau of Mines, 1930, pp. 15-16.

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At Tintic Standard contracts are seldom let, according to Wade,[21] who states:

> Contracts here are virtually bonus systems. So-called contracts consist of verbal agreements to guarantee wages and also to pay a stipulated price per foot for direct labor. These contracts are let only on drifts, raises, shafts, and winzes and are really negligible; contracts let in 1929 amounted to less than 1 per cent of the pay roll and in 1928 there were none.

Copper Mines (underground), Southwestern States.- Development is nearly always on "contract" per foot with wages guaranteed; stoping is on "contract" per cubic foot or on bonus for extra tonnage; tramming is on bonus for extra cars over base number or on day's pay; timbering is on day's pay or "contract" per set stood. At Bisbee, most work is on a bonus system. Probably 80 per cent or more of all work is on a contract or bonus system.

Contract and bonus systems have become highly developed at these mines; many of them are broadly similar to each other but embody differences in detail which have been evolved to meet local problems of administration or because of the individual views of the managements. The descriptions cited below are deemed worthy of inclusion in this paper because they not only present a picture of efficient systems, but serve as well to afford a comparison between systems which have been developed under broadly similar but locally divergent conditions.

United Verde.[22]

> A fair amount of work done safely by an average man in a given unit of time is the standard for any particular job. The efficiency of the job is calculated as follows:
>
> If a standard for a job is one unit per shift, and a man accomplished 1½ units per shift, he is rated as being 150 per cent on that job. He receives as bonus one-half of his increase in efficiency over 100 per cent, or 25 per cent of his day's pay rate. The company benefits by the other half. Putting this into a formula, it may be expressed as follows:
>
> $$T_2 = P \mid S;\ E = T_2 \mid T;\ B = 1 \mid 2(E - 100)\ W$$
>
> S = standard (unit of work per unit of time)
> P = work accomplished
> T = time required for doing P
> T_2 = time allowed for doing P according to S
> E = efficiency in per cent
> W = wage rate per unit of time
> B = bonus paid
>
> Obviously, the major problem is to determine correct standards of work. The setting of standards depends largely upon past performance and upon the judgment of the man setting the standard. The men chosen to set rates must have had considerable experience themselves in doing and in bossing the work they are rating. Such a man inspires the respect and confidence of the workers. The foremen are consulted whenever a new standard is to be set.

21 - Wade, James W., Mining Methods and Costs at Tintic Standard Mine, Tintic District, Utah: Inf. Circ. 6360, Bureau of Mines, 1930, p. 14.

22 - Quayle, T. W., Mining Methods and Practices at the United Verde Copper Mine, Jerome, Ariz.: Inf. Circ. 6440, 1931, pp. 21-25.

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Since 1924, a good deal of work in the mine has been paid for on a contract system. Practically all of the new timber work, drifting, crosscutting, and raising is done on contract. However, what we call a contract is not a contract in the true sense of the word, because the agreement is verbal and the man assumes no obligation. The company agrees to pay a certain price for a certain unit of work, but the man is guaranteed day's pay no matter how much he accomplishes. Also, the company retains the right of complete supervision over the work and the manner in which it is done. The contractor has nothing to say about who his coworkers or helpers will be, though, of course, an attempt is made to put men together who have equal ability and who will work together to advantage. Each man is responsible to the company only and they are paid separately by the company. Two examples of contracts follow:

A. Credit 10 chutes at $10 =	$100.00	Deduct 5 shifts at $5.23 =	$26.15
	49.55	5 shifts at 4.68 =	23.40
Due contract	50.45	Total deductions	$49.55

Due timberman in addition to day's pay: 53 per cent of $50.45 = $26.75
Due helper in addition to day's pay: 47 per cent of $50.45 = $23.70

Division of the profit is made according to the ratio of the day's pay of the two.

B. A drift is driven under contract at a price of $5 per foot. This price includes mining labor and explosives only, as the mucking is let separately. The miner drives the drift 100 feet in 20 shifts and uses 30 boxes of powder.

Credit 100 feet at $5	$500.00	Deduct 20 shifts at $4.95	$99.00
	339.00	30 boxes powder at $8	240.00
Due contract	$161.00	Total deductions	$339.00

Miner receives $161 plus day's pay for 20 shifts.

Two advantages of this type of contract over the bonus system in use here are that the contract is easily understood by the miner and he visualizes his units of work accomplished in dollars, which acts as an incentive to greater industry. Also, in the case of development work, it rewards the miner for saving explosives, while under the bonus system the tendency is to be extravagant and wasteful of explosives.

This type of contract has been very successful in lowering unit costs and in increasing the earnings of the men. It has been tried to a limited extent in mining in stopes and within the next year will be given a thorough tryout for all extraction operations.

A great deal of care must be taken to set a correct contract price in this method of payment because the company does not participate in the bonus, and if the price is set too high the unit cost to the company will be too high.

A great many of our contract prices have been arrived at from the bonus standards, in conjunction with the average bonus earned over a long period of time on a given class of work. For instance, the price of a drift would be set as follows:

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The bonus standard for the drift might be 2 feet per shift. The average bonus for drift work was somewhat under 50 per cent, but good miners, under favorable conditions, often made 50 per cent or better. To make 50 per cent bonus in the above drift, the miner would have to average 4 feet advance per day, and this would cost the company $4.95 plus 50 per cent of $4.95, equalling $7.42, or $1.855 per foot for labor. Then, if $1.90 per foot were allowed for explosives, the contract price would be $3.75 per foot. If the miner broke 4 feet per shift and just used the allowed amount of powder, he would make just the same amount of money as if he worked under the bonus system. To make more money on the contract than on bonus, he would have to reduce the amount of powder used per foot or increase the amount of advance per shift. If he fails to make an advance which would have paid 50 per cent bonus under the bonus system, or if he uses an excessive amount of powder, he will not make as much as if he were on bonus instead of contract.

The company gets the work done at a certain fixed price whether the miner makes a good bonus or not, unless he shows a loss. In case of a loss by the contractor, the cost to the company is increased by the amount of the loss over the agreed price.

If the contractor is not doing reasonably well, an investigation is made of the conditions governing the operation, and the contract price is changed if unforeseen difficulties have arisen. If, however, the fault is found to be with the contractor's ability, he is either transferred to some work he is better fitted to accomplish or he is discharged.

The contract price is subject to change at any time if conditions over which the contractor has no control are changed. For instance, the formation in a drift may change from soft to hard rock, in which case a new price would be set starting at the contact. If an error, due to misjudgment, has been made in setting the contract price, the change in price is retroactive and starts when the work started if the original price was too low. If the price was set too high, the cut does not take effect until the first of the month following the time the mistake was discovered. Although this gives the men an advantage over the company, it tends to inspire their confidence in the system.

Most of the underground work and all of the mechanical and open-pit work is still under the bonus system. Various types of standards or allowances are set for the different operations according to our ideas of what seems to be the most equitable method of settlement.

Type of work	Unit of standard
Underground work:	
Mining in drifts and crosscuts	Feet per shift advance
Mining in stopes	Cubic feet per shift broken
Laying track, hanging pipe, etc.	Feet per shift installed
Hoisting ore	Skips per shift hoisted
Hauling ore	Cars per shift hauled
Mucking	Cars per shift filled
Open-pit work:	
Trucking ore	Tons hauled per shift
Electric shovel operation	Cubic yards dug per shift
Truck maintenance	Dollars allowance per truck shift

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Type of work	Unit of standard
Mechanical work:	
Machine work	Given number of hours allowed per unit of work
Sharpening drill steel	Time allowance per rock-drill shift

The above are only a few examples of the many operations, but they are representative. The drill steel sharpening standard is not based on the number of pieces of steel sharpened, because when this method of payment was tried, the operators burned the steel in an effort to increase their production. When burned steel went underground, the bit soon failed and the steel was out again for resharpening. This tended to increase the work in the sharpening shop, and thus the men were paid a premium for doing poor work. Under the present system, when perfect steel is sent underground, a minimum amount of resharpening is required, the shop crew is as small as possible and a maximum of bonus is made by the men, so that the premium is now paid for good and efficient work. The same method of payment is used in the rock-drill repair shop. They are allowed so much time per drill in operation, so that drills sent down in perfect order will stay down the longest time possible and reduce the work in the shop to a minimum, thus allowing the men a maximum of bonus. This method of reward does very well for maintenance and repair work where certain equipment is in constant use and requires constant attention.

The organization of the bonus department consists of a chief bonus engineer, an assistant chief bonus engineer, an office clerk who posts the time of the workmen on the various job sheets, four bonus engineers who handle the underground work, and two bonus engineers who look after the outside and mechanical work.

The engineers take the cubic feet broken, explosives used, cars trammed, etc., from the shift bosses' distribution sheets each day. They are constantly visiting the working places, so that they are fully acquainted with the details of the work going on. Each engineer computes the efficiency of all the jobs under his jurisdiction, and the computations are then checked by the head of the department or the assistant.

The number of men required to carry on bonus work depends largely on the number of jobs. In turn, the number of jobs depends on the amount of attention which it is thought advisable to spend on the details of each major operation. For example, the shops may be given the job of completely overhauling a Mallet locomotive. A standard of 500 shifts might be set for the total job. This would be one job and would require very little work from the bonus engineer after the standard was set. The job might be divided into machine work, boilermaker work, steam fitting, and electrical work, making four jobs out of one, which would require practically four times as much work in the bonus department. Or, each individual operation on the overhaul job might be considered as a separate job, rates set, time kept, and the computations made on a great many details which would take considerable time on the part of the engineer. This last method of handling the bonus is the most accurate and is the method employed where the results obtained justify the cost of the clerical and engineering work. In some cases, it would cost as much to obtain an accurate standard on a particular job as it would cost to do the work. This is particularly true for work which is done once and is not repeated. In such a case no attempt is made to set a stand-

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ard for the job. If the men doing such work have been regularly working on bonus, they are paid a flat rate of bonus for the time spent on the job. This does not furnish any incentive for faster work, but it prevents dissatisfaction on the part of the men required to do the work, and it is cheaper than spending the time to obtain a standard.

Some of the regular work about the plant is of such a nature that it is impractical to put it on a bonus basis, and such work is done on "company time," no bonus being paid over the daily wage rate. If a man works part of a shift on a bonus job and part of a shift on a company-time job, he will be inclined to charge most of his time to the company-time job so as to increase his bonus. The boss must therefore keep the men's time carefully and accurately.

The bonus is figured on the first of each month for the work done the previous month, and the money earned is paid on the check the men receive on the 21st of the month. In case a man quits during the month, his bonus is mailed immediately after the bonus pay day.

We have found that in every case where a fair standard has been set for bonus work, it has resulted in lowering the cost of that operation, and that the men doing the work earned more money than before.

Bisbee.[23]

At the Bisbee mines the bonus system is employed in a part of the development work and for some stoping.

In the case of development work, standards are set by the mine foreman and approved by the superintendent of mines. Bonus is paid on the measurements made by the engineering department. No penalty clauses for lack of making a standard are included, as daily wages are guaranteed.

In stoping, the bonus basis is set on tonnage per man-shift. This is determined from stope tonnage records.

Pilares.[24]

In 1929, 78.75 per cent of the workmen underground were on the contract basis. A contract wage scale has been prepared covering practically all classes of work underground, as well as many operations on the surface. All development work is on a contract rate per meter of advance. The size of the opening, class of ground, and working conditions control the variations in price. For raises the height of the raise is also a factor. In drifts and crosscuts the mucking contract is often separate from the drilling contract. The price is based on the meterage advance per round blasted, with variations for size of opening and distance for tramming.

All timbering in drifts and crosscuts is contracted at a price per set placed.

Stoping is contracted at a price per cubic meter. Different rates are paid for different types of stopes. There is a contract price for breaking, mucking, and timbering. In addition, there are prices covering all extra work, aside from

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23 - Lavender, H. M., Mining Methods at the Campbell Mine of the Calumet and Arizona Mining Co., Warren, Ariz.: Inf. Circ. 6289, Bureau of Mines, 1930, p. 12.

24 - Leland, Everard, Mining Methods and Costs at the Pilares Mine, Pilares de Nacozari, Sonora, Mexico: Inf. Circ. 6307, Bureau of Mines, 1930, pp. 28-29.

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the regular operations in the stope, such as for the placing of bulkheads, umbrella stulls, extra lagging, and flooring, so that the contractor is paid for everything he does. This has resulted in a receptive attitude on the part of the contractor toward safety orders, suggestions requiring the placing of extra timber, or the performance of any other extra work in the interest of safety or better efficiency.

All contracts are given to one man. He is held responsible for the safe performance of the work, according to standard practices laid down, and hires the necessary men. This does not in any way relieve the boss in charge of the responsibility of seeing that the safest, best, and most efficient methods are followed. However, the bosses' dealings are confined to one man in each working place.

The company advances to all contractors underground the sum of 3.25 pesos per shift, which is charged to the account of the contractor. This amount is deducted from contractor's account on settlement day, which is every two weeks. Where powder is used the amount per unit required is allowed on the contract in money, and the contractor's account debited with the amount actually used. If the contractor uses powder judiciously a small profit will generally accrue to him.

Measurements of all development are made weekly by the engineering department, and a settlement is made the same week with the contractor. Stopes are measured by the engineers every two weeks, and settlements made the same week. As a protection to the contractors' helpers the contractors are required to furnish to the accounting department, prior to the liquidation date, a list of men employed and the rate of pay promised each. These amounts are passed to each man, and the contractors' accounts debited, provided there is sufficient money to cover. If not, rates are pro rata. Contractors failing to make sufficient money to cover the guaranteed daily wage of 3.25 pesos for three consecutive periods automatically lose their contract.

The contract wage scale is elaborate and covers practically every class of work of whatever nature, both underground and on surface, for which a contract price can be fixed. Variations in prices are provided to cover all ordinary variations in each class of work. Any unusual conditions involving special prices not provided for in the wage scale are referred to the mine superintendent for his approval.

This wage scale is the result of years of experience under the conditions peculiar to this mine, and it has been adjusted from time to time to meet changing conditions, with the idea of so arranging prices that equal effort on the part of the workmen in similar classes of work will insure equal compensation.

The checking of work performed is carefully tied down by engineers' measurements or count. In case of doubt the workman gets the break, and when prices are given they are not changed until the following measurement period, unless an erroneous price, unfair to the workman, has been made. In this case, it is rectified at once.

The result has been highly satisfactory, and it is seldom that a just complaint is ever registered by a workman.

Morenci.[25]

25 - Mosier, McHenry, and Sherman, Gerald, Mining Practice at Morenci Branch, Phelps Dodge Corporation, Morenci, Ariz.: Inf. Circ. 6107, Bureau of Mines, 1929, pp. 27-29.

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For the year 1928, 72 per cent of all labor in the mining department was paid on bonus or contract systems. The other 28 per cent was on day's pay.

Contracts.- A standard set of contract prices is in effect throughout the mine. The foremen who let the contracts have copies of the contract schedules. These contract prices cover such work as drifting, raising, and winzing--both driving and timbering--laying track, digging ditches, undercutting and shrinking in stopes, and salvaging mining material. The rates are followed very closely and seldom changed. Unusual conditions are stated on the contract form and authority for changes from the standard must be obtained from the mine superintendent before a contract is let. All measurements are made on the 15th and 30th of each month, and the earnings are computed by the engineering department. All men on contract are guaranteed day's pay at the prevailing wage. The time and class of work done by each man on a contract is recorded by the shift boss.

The manner in which this contract system differs from systems employed at many mines lies in the way in which the proceeds of a contract are shared among the workmen participating. The earnings may then be divided by any one of four methods: (1) An equal division of earnings to all men concerned in the contract; (2) the payment of day's-pay rates to all according to their respective day's pay-rates, with an equal division of the surplus; (3) payment of day's-pay rates to all, then a division of the surplus in proportion to his day's-pay rate; (4) straight payment to each man for the work that he does, having separate prices on timbering, mining, mucking, etc. The choice of the method of dividing the proceeds of the contract is left to the discretion of the foreman, who is familiar with the work, its conditions, and the desires of the men.

Bonus.- A bonus system is applied to men working in stopes and on transportation crews. In arriving at the bonus rates past daily performances of men employed at various classes of work have been averaged to determine a "base" for each class. This base represents the amount of money that would be paid if a man does an average day's work, and corresponds to a day's pay. This figure divided by the number of tons representing an average day's work is called the "base cost per ton" (or other unit). If a man exceeds an average day's work he is paid one-half his "base cost per ton" for each unit by which he exceeds average day's work.

The base in each working place is subject to change at the beginning of a pay period if conditions should warrant it.

At the drill-sharpening shop the proposal was made to the men that one-half of any saving in labor effected by a reduction in the force would be divided equally among the men in the shop. This ruling had the effect of raising the quality of the bits turned out, because with a higher standard of bit there was less work in the shop and less men were required. The base number of men is subject to change at the discretion of the mine superintendent when any of the operating conditions undergo changes, such as variation in amount of work done in the mine, change in shop practice, change in shop equipment, or change in scale of operations. The drill-shop foreman was not included in this bonus.

The mine shift bosses do not receive a production bonus but do participate in an accident-prevention bonus based on a graduated scale for each 1,000 shifts supervised without an accident.

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Inspiration.[26]

All development work can be contracted in small units to men who have the desire to increase their daily earnings by increased effort or the more intelligent application of their skill. Contracts in small units are desirable from the viewpoint of the company, but more particularly from the viewpoint of the employee. If a contract does not prove to be profitable, the man realizes that he does not have to continue the job for a long period. Although the contractor can not be paid below the standard wage paid in the district for the class of work being done, it has been found that when a contractor falls below the minimum rate of pay, and he knows this without being told, he is apt to fall below the standard in the quality and quantity of work done. That is where the company suffers if the contract is continued. With a small contract, adjustments of rates of pay can readily be made. The adjustments may be necessary on account of unforeseen ground conditions, or on account of supply and ventilation conditions which may have had to be changed for operating reasons. Each contract stands on its own basis. Usually it is true that the same class of work in a division is priced the same, but small units readily allow minor adjustments.

However, the great advantage of any contract system over any bonus system is that a contract system is based upon a unit of work done for a specified price. It can be terminated by either the employee or the company, since it involves an understanding by both parties and has to be mutually satisfactory. It should be remembered that the so-called contract system at Inspiration is just an opportunity for an employee to make more than the base rate of wage for the class of work being done. The contract should, of course, return a profit to the company as well as to the contractor.

To arrive at an equitable bonus system for mining operations is exceedingly difficult, and it is considered at Inspiration that it more readily lends itself to abuses and injustices than a well-managed contract system. After once started, a bonus system is harder to terminate or change than a contract system, as a contract is based upon a particular piece of work and the bonus upon a class of work.

Magma.[27]

During 1928 from 60 to 75 per cent of all work underground was done under contract or bonus systems. Rates per foot for drifts and crosscuts are based upon the size of opening, location, and general working conditions. All timbering in drifts and crosscuts is contracted at a price per set. Sliding scales for raises are based upon the height of the raise, the rate per foot increasing every 50 feet. Shaft sinking is done under a bonus system, the bonus being figures on ¼-foot advance. Stoping is contracted for at a price per cubic foot. Different rates are paid for different types of stopes.

All men on contract are guaranteed company wages. The man responsible for the contract in drifts, crosscuts, and shaft sinking is paid extra for managing

26 - Stoddard, Alfred C., Mining Practice and Methods at Inspiration Consolidated Copper Co., Inspiration, Ariz.: Inf. Circ. 6169, Bureau of Mines, 1929, p. 20.

27 - Snow, Fred W., Mining Methods and Costs at the Magma Mine, Superior, Ariz.: Inf. Circ. 6168, Bureau of Mines, 1929, pp. 25-26.

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the contract. Each man draws the regular wage for the work he is doing; the remaining amount due on the contract is divided equally among those participating. Measurements are made by the engineering department on the 1st and 16th day of the month. The contract earnings are figured by the mine superintendent and the auditing department.

Contracts are let by the mine foreman subject to the approval of the mine superintendent and general office.

From Jan. 1, 1922, to October, 1928, the wage scale per shift at the Magma mine was as follows:

Miners	$4.95	Brakemen	$4.13
Timbermen	5.23	Pipemen	4.68
Shovelers	4.13	Cagers	4.68
Hand trammers	4.13	Trackmen	4.95
Motormen	4.68	Nippers	4.13

In October, 1928, a 10 per cent increase in rates was put into effect. At this mine, as in all the important copper-mining districts in Arizona, the standard scale or base rate is paid when copper is at or under 15 cents per pound. Informal increases of 5 or 10 per cent are made at each 2 cents per pound increase in the price of copper. Corresponding decreases are made when the price of copper is reduced.

Ray.[28]

Contracts.- A set of standard contract prices is in effect throughout the mine embracing all work that can be handled satisfactorily by the contract system. These prices cover drifting, raising, sinking, timbering, retimbering, undercutting and stoping, and the reclaiming of timber and track material. All prices are on a per-foot basis with the exception of stoping, timbering, and the reclaiming of timber and track material. In the case of stoping and undercutting the price is based on what is locally termed "vertical lineal feet;" that is, a base price is made for each vertical foot of stoping, the actual price for any individual stope being the vertical price per foot times the lineal length of the stope. In case of timbering, a price is given for each set. In reclaiming timber a price is paid on a basis of board feet of timber recovered and in the case of track, pipe, etc., the price is based on the actual linear feet recovered. The contract rates in effect are seldom altered and then only with the approval of the mine superintendent. Contract work is entirely in charge of the engineering department and is supervised by a contract engineer, whose duty it is to sign new contracts and to keep in touch with the work as it progresses during the month. Contracts are signed for a month's duration only. They are measured on the last day of each month, no excess earnings being paid to the contractors on the mid-month payday. All men on contract are guaranteed day's pay. The contractors themselves are directly responsible to the mine boss in those sections they may be working, and it is the mine bosses' duty to see that the work is carried on in a workmanlike manner. Such earnings as may be made in excess of the

28 - Thomas, Robert W., Mining Practice at Ray Mines, Nevada Consolidated Copper Co., Ray, Ariz.: Inf. Circ. 6167, Bureau of Mines, 1929, pp. 21-22.

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daily wage are proportioned to the men working on the basis of their daily wage, except that the contractor himself is allowed 25 cents extra per shift for assuming the responsibility of the contract. All contracts cover labor only, and all supplies are furnished by the company. Contracts have been tried at various times to cover the drawing of muck from the chutes, all tappers in any one area being considered on the contract and the basis of pay being so much per car of ore produced. Such contracting improves the efficiency of the drawing operations, but is not satisfactory, as it is almost impossible to maintain control of the draw.

Bonus.- With the present contract system, which borders on the bonus system, very little actual bonus work is done. A bonus is paid trammers for the tramming of muck from chutes, and a definite amount per car is paid for all cars in excess of a certain number. The base number of cars depends on the length of tram. In addition to the contract price paid for drifting and raising work, a bonus is sometimes allowed on rush headings of so much per foot, providing a certain footage is completed during the month.

A bonus is also applied to work in which great difficulty is being experienced. This in effect raises the contract price, except that the bonus is not paid unless some agreed footage is completed during the period.

Open-pit Copper Mines, Southwestern States.- At the open-pit copper mines nearly all work is on a day's-pay basis. Some isolated jobs, such as construction, etc., are let out on contract at Bingham.

At the United Verde mine, however, bonuses are paid and are described by Alenius[29] as follows:

An efficiency bonus based on the work performed is also paid for most classes of labor. Standards are set for each class of work and a record is kept of the performance of each man or group of men. The men are paid on a basis of one-half of the work performed in excess of the standard amount. For instance, if the efficiency is 150 per cent, the workman receives 25 per cent of his base rate as a bonus. In some cases the bonus is figured on the basis of individual work; in others the performance of a group is considered.

Southeastern Alaska Gold Mines.- The Alaska-Juneau is the only large mine operating in southeastern Alaska. Here 75 per cent of the underground labor is on contract and the other 25 per cent share in a bonus based on over-all tons per man-shift. The main haulage is on a subcontract.

P. R. Bradley,[30] consulting engineer for the Alaska-Juneau mine, states:

It's the careful picking and training of men for a specific task, such as driving powder drifts, running up raises, etc., that has been largely responsible for the low costs at the Alaska-Juneau mine.

In his paper, Information Circular 6186, he states further:

29 - Alenius, E. M. J., Methods and Costs of Stripping and Mining at the United Verde Open-Pit Mine, Jerome, Ariz.: Inf. Circ. 6248, 1930, p. 32.

30 - Bradley, P. R., Mining Methods and Costs, Alaska-Juneau Gold Mining Company, Juneau, Alaska: Inf. Circ. 6186, Bureau of Mines, 1929, pp. 10-11.

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Bulldozing, loading, and tramming, and all mine developments as well as preparatory mining work, is done by contract. Some of the features that have made the contract system successful, are:

The guarantee of a reasonable base wage for contractor and men.

The close supervision of work and the prompt adjustment of price when justified by changed conditions.

The careful selection of men for contractors, and the prompt elimination of such contractors as are unable to earn more than base wages at a reasonable contract price.

The furnishing of good equipment and its maintenance in good condition, with plenty of steel and good air pressure.

Maintaining the same price for explosives, regardless of market change.

The inclusion of two or more working faces in the same contract whenever practicable to obtain more nearly average drilling and breaking conditions.

He then describes in detail the stipulations of the various contracts as follows:[31]

The contract system has proved highly satisfactory. The men make better wages and the unit costs are less than they would be under straight day's pay. Supervision is reduced to a minimum, and the inclusion of day's-pay employees into the contracts indirectly, through a share of the earnings, swings them into the contractors' stride. The general result is an "esprit de corps" and genuine interest in the work on the part of the underground crew.

Ontario Gold Mines.- Some mines are on an all day's-pay basis, most perform development on bonus or contract where possible, and a few are trying a bonus system throughout.

At the Teck-Hughes mine in the Kirkland Lake camp, according to Henry,[32] day's pay prevails underground. Henry states that:

All employees below the rank of foremen are paid by the day. The rates are:

Shift bosses	$7.00
Mucker bosses and chute blasters	5.00
Samplers	5.00
Drill runners, timberman, and scalers	4.75
Pipefitters, tracklayers	4.75
Shaftmen	6.00
Muckers, trammers, and drill helpers	4.25
Nippers, deckman	4.25

Contracts are rarely let and then only for shaft sinking.

Development is done on a bonus system. Shovelers are paid 37 cents per car and earn about $7 per day. Two drill runners are paid $3 per foot advance in drifts and crosscuts, and four runners are paid $6 per foot in inclined raises. Bonus earned is about $2 per shift.

31 - Bradley, P. R., Work cited.

32 - Henry, R. J., Mining Methods and Costs at the Teck-Hughes Gold Mines (Ltd.), Kirkland Lake, Ontario: Inf. Circ. 6322, Bureau of Mines, 1930, pp. 7-8.

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Labor is about 40 per cent British, 40 per cent Finnish, and 20 per cent Hungarian. The bulk of the development is done by the Finns.

No labor union of any strength exists in the district, and no strike or labor trouble of any kind has occurred since 1919.

At the rates for bonus enumerated above, development is done more cheaply than by payment of only the regular rates of labor; the bonus provides an incentive for the newer employees who are only placed on bonus when they have demonstrated their ability to do good work.

In regard to the method of paying labor at the Vipond mine in the Porcupine district, Dye[33] comments as follows:

All work below ground except in drifts and crosscuts is done on day's pay. The wage rate is: Shift bosses, $7 per shift; miners, pumpmen, scalers, trackmen, cage tenders and powdermen, $4.80 per shift; timbermen, $4.80 and $5.05 per shift; muckers, helpers for machinemen, and helpers for timbermen, $4.24 per shift.

The driving of drifts and crosscuts is done on a bonus system. At one time the work was done on a so-called contract basis by which workmen were guaranteed the regular scale of wages but were given the work to do at a price per foot; they furnished the explosives and the labor for drilling, mucking, and tramming. Unless the price paid was frequently changed to meet the varying conditions encountered, it was found that circumstances over which the workman had no control either made it impossible for him to make any bonus at all, or the bonus worked out at a figure which was obviously more than a just reward for any special skill and effort which he might bring to the task. The company found itself in a position where it suffered all the extra cost due to any adverse conditions encountered and did not benefit by unusually favorable conditions, if and when these were encountered. The system now employed does not entirely eliminate this difficulty, but it does to some extent, and it does reward good work under all conditions and at the same time leaves the company in a position to share in the benefits when the work is being done in easy ground.

The bonus now paid is for footage advanced in any month in excess of 4 feet per shift worked, and is as follows:

The drill crew is paid $4 per foot for all footage in excess of an average of 4 feet per shift worked. An allowance of $2.50 per foot advanced is made for explosives and the crew is credited with one-half of any saving they make, or charged with one-half of any explosives used in excess of this amount. The bonus due the drill crew on the above basis is then split three-quarters to the drill runner and one quarter to the helper.

The muckers are paid 50 cents each for footage in excess of an average of 4 feet per shift.

Chile Copper Mines.- Most of the copper mines in Chile used a contract system for the greater percentage of their operations. A good example of efficient handling of labor is described in the paper on the Braden Copper mine as follows:[34]

33 - Dye, Robert E., Mining Practice and Costs at the Vipond Mine, Timmins, Ontario, Canada: Inf. Circ. 6525, Bureau of Mines, 1931, p. 8.

34 - Webb, J. S., and Skinner, T. W., Mining Methods and Costs at the Braden Copper Co.'s Mines, Sewell, Chile: Inf. Cir. 6565, Bureau of Mines, 1932, pp. 10-11.

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In 1928, 70 per cent of all underground mine labor was paid on contract basis.

A standard set of contract prices is in effect throughout the mine, covering all such work as drifting, raising, winzing, stoping, undercutting, tramming, steel sharpening, and timbering, both for standing new sets and for repair work.

All men working on contract are guaranteed day's pay, earned at the base rate of the occupation involved.

A bonus is paid on rush work, such as driving drifts or tunnels, where speed is an important factor. This is arranged on a meterage basis, an additional payment being made for every meter driven over and above the predetermined monthly average for the particular type of ground in which the work is being done.

WELFARE WORK

A few examples of what some mining companies are doing in welfare work for their employees will show the general attitude of the mining industry toward labor.

In an article describing the welfare work of the Cleveland Cliffs Iron Co., by W. H. Moulton,[35] are the following statements:

> The well-being of the employee of any company is fully as important a factor in its successful operation as the condition of the mechanical or other equipment, and should receive just as careful consideration. Many plans are undertaken by The Cleveland-Cliffs Iron Co., in a spirit of friendship and good will toward its employees, as well as because of a rational understanding of their economic value.
>
> The first thing of importance is the condition under which the men work, both in the matter of health and safety. Efforts have been made to surround the men at the mines with healthful conditions, and everything possible has been done to promote the safety of the employees in the operation of the different properties.
>
> Equal in importance to proper working conditions is that of satisfactory living conditions. It has always been the policy of the company to provide good homes for the employees, at a very moderate rental.
>
> The matter of good sanitation has always been carefully looked after, both at the mines and at home locations. The excellent system of ventilation in operation at the mines is one illustration of the benefit which has resulted from a study of conditions. This improvement means better health and longer life for the men.
>
> An excellent medical service has been maintained to insure the best of care for the employees and of their families. Hospitals have been erected, served by the most faithful and competent physicians.
>
> Consideration has been given to those men who after long years of faithful service have at last found it impossible to continue at work by reason of age or disability. Pensions have been provided for the men reaching the age of 65 and who have worked for the company 25 years or longer.
>
> A well-considered community life has a large share in the encouragement of ideals and every reasonable effort has been made to provide and maintain those conditions that will be the most helpful. Club houses have been erected with

35 - Industrial Relations Work of the Cleveland-Cliffs Iron Company. by W. H. Moulton. The Mining Congress Journal Oct., 1929, p. 771.

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such facilities and arrangements as to serve the whole community. The club houses have the usual equipment of billiard and pool table, bowling alleys, game rooms, gymnasium and recreational halls, shower baths, and special rooms for the use of the women. One of the club houses in addition to the other features has a fine swimming pool.

B. C. Yates, general manager of the Homestake Mining Co., states as follows:[36]

Social engineering is a comparatively recent branch of executive responsibility, but the Homestake company takes pride in the thoroughness of this phase of its operations. No expense has been spared to provide medical, recreational, and educational facilities, to prevent accident, to take care of the injured, to provide insurance against old-age survival, and to care for the dependents of employees. The company has also contributed largely to the support of church activities in the region in which it operates.

Hospital and medical service is free to all employees and to their dependents. A pension system, established in 1917, maintained solely at the expense of the company, provides that an employee may be retired on account of old age, physical disability, or disease. Every effort has been made to encourage the development of an independent, free-thinking, and free-acting community of people, able to govern themselves as real Americans. As a result of this policy, the town of Lead has grown up to become a community of home owners who possess civil pride as well as loyalty to the company. The policy has ever been to recognize the rights of employees and to treat them fairly. Any employee, whatever his position, has ready access to the general manager to state grievance or to suggest a new idea in regard to his work. The regarding of loyalty and zeal has insured an unusual continuity of service.

STATEMENTS ON LABOR BY CERTAIN MINE MANAGERS AND ENGINEERS

According to P. R. Bradley, consulting engineer of the Alaska-Juneau mine, "It's the careful picking and training of men to do one job well that has resulted in the low costs at the Alaska Juneau mine."

Mr. Brennon, mine superintendent at the Britannia mine in British Columbia, where the output per man was doubled during 1931, states that the increased efficiency has been largely due to the contract and bonus systems and the necessity of the entire force, including the workmen, to speed up the work. All knew that if the production cost of copper could not be reduced to the market price, operations would have to cease. The workmen at Britannia are encouraged to use their heads, and their opinions are given consideration. This recognition makes them take a greater interest in their work. The management is naturally interested in keeping the more efficient workmen and is doing so by maintaining better quarters, a good trading store, movie house, men's club, and competitive sports.

E. T. Stannard, vice president, Kennecott Copper Co., in reference to the management of labor at the Braden mine, makes the following remarks:

"Grief," as it is called in connection with troubles, is a sign of poor management. Choked ore passes, loss of time due to lack of cars, etc., can generally be traced to negligence on someone's part.

36 - Executive Direction and Social Engineering, by B C Yates, Engineering and Mining Journal, Oct 12, 1931, p 291

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> Workmen as a class tend to render as small an output of work and of as poor a quality as they can possibly get away with. However, we owe a certain responsibility to the men who have to do the physical work and should provide for their safety and study out methods to make their work easier. The boss most immediate to them should take a personal interest in his men, know them by name, and see that they make wages by showing them better ways to do their work. There must be concerted effort so that every man will do his part willingly and to the best of his ability. Such a system of approach will make the day's work easier for both men and bosses.

Scott Turner, director of the Bureau of Mines, in his annual review of mining progress, published in Mining and Metallurgy last month, states:

> As the cost of mining depends largely on the efficiency of the workmen, such questions as pay systems, handling of labor, control of operations, and mine-office management are being studied more than ever. It is an outstanding fact that those mining companies where the management has taken a special interest in the individual worker, supplying him with the necessary comforts of living and entertainment, and making him realize that he is a responsible part of the producing force, thus developing his loyalty, are the companies that have achieved the lowest mining costs, the lowest labor turnover and the lowest accident rates.

Mr. Lucien Eaton, from the Marquette iron district, states that "the secret of good management is to take away obstacles in front of men and make everything simple by careful planning beforehand; have a definite method to determine exact amount of work done; see that workmen on contract make a good wage, and that there is a confidence between captain and contractor for a fair deal."

In a paper presented at the February, 1932, meeting of the American Institute of Mining Engineers, the writer, who spent 20 years managing mines in Sardinia and northern Italy, stated:

> For efficiency in operation the management should first see that the best system is developed in respect to gaining a particular objective, and then plan ahead for the work in all of its details, instruct the men in the best ways to do their work, and give them the incentive to work.

The three essentials for the mine manager to follow are.

(1) Caution in selection of men and the pay system.

(2) Concentration in the planning and supervision of the work to see that nothing is lacking to promote progress.

(3) Consideration of the individual workman to see that he and his family are well taken care of.

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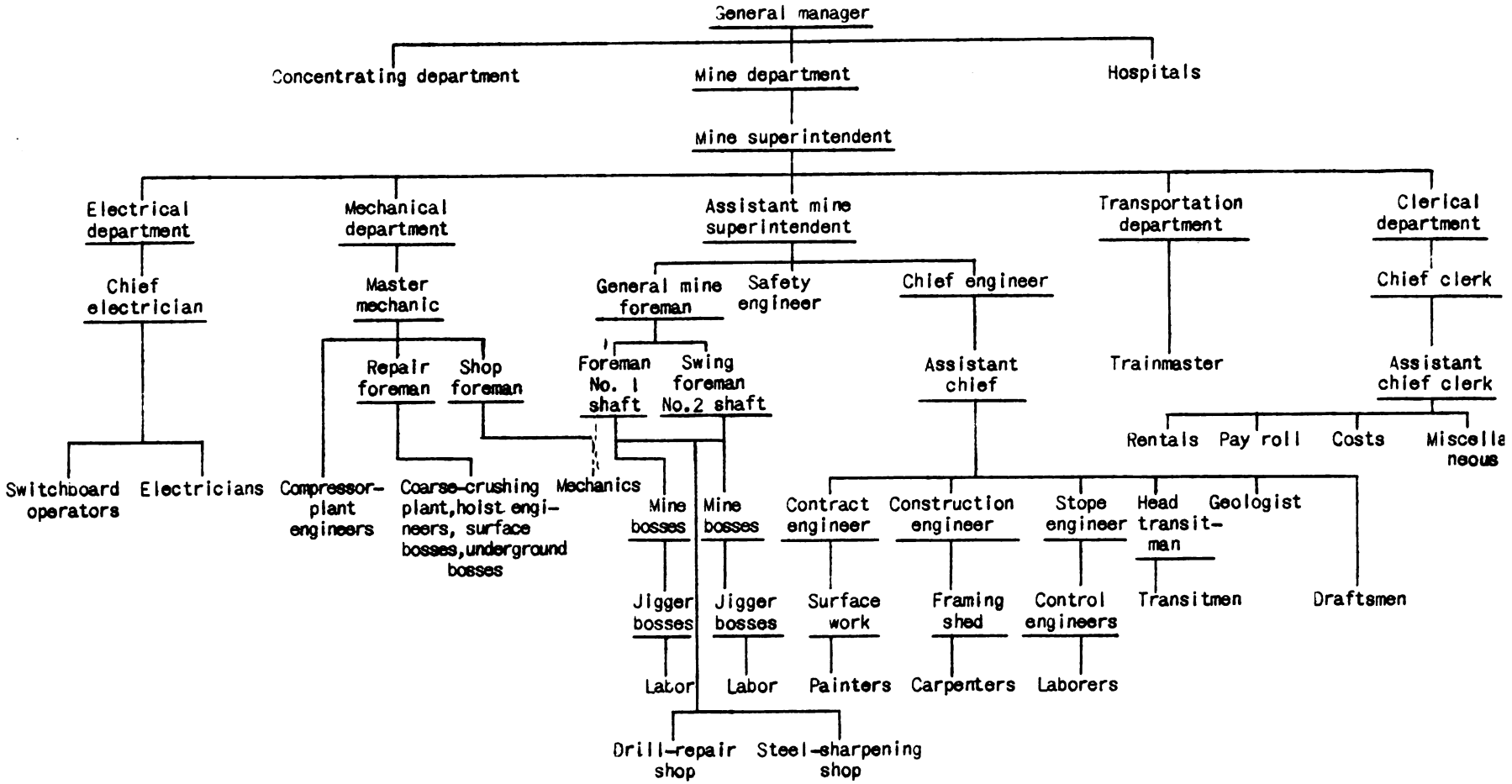

Figure 4.- Organization chart of the Ray mine of the Nevada Consolidated Copper Co., Arizona

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